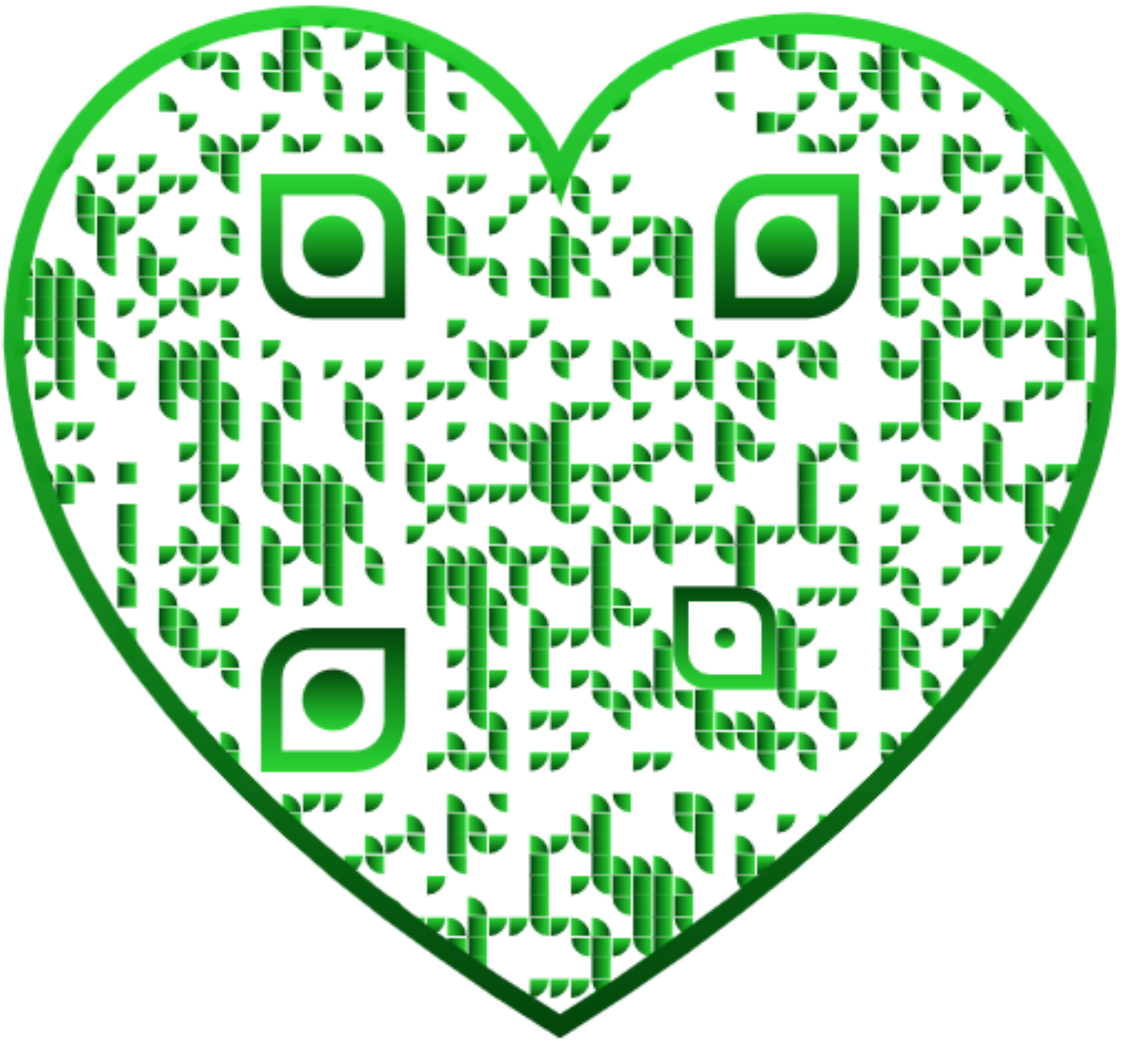
Chapter Three

Decision Analysis and Pharmacoeconomic Evaluations



Objective of the chapter

At the end of this chapter, students are expected to

- Describe basics of probability
- Understand economic and PE evaluations
- Identify steps in decision analysis
- List, differentiate and apply various decision models

Outline

1. Basic Concepts of Probability
2. Definition and Theoretical Basis of Decision Analysis in Health
3. The Basic Steps of Decision Analysis
4. Evaluation of the Result of Decision Analysis
5. Possible Benefits and Common Criticisms of Decision Analysis in Health

Basic Concepts of Probability

- Because medicine is an inexact science, physicians seldom can predict an outcome with absolute certainty.
  - Example: to formulate a diagnosis, a physician must rely on available diagnostic information about a patient
    - History and physical examination
    - Laboratory studies, X-ray findings, ECG, etc
- Although no test result is absolutely accurate, it does affect the probability of the presence (or absence) of a disease.
  - Example, We may hear a physician say that a patient has a 50—50 chance of surviving a certain operation.
  - **Example**: histidine-rich protein (HRP2), as the antigenic marker. HRP2 is water-soluble protein secreted by *P. falciparum* trophozoites (asexual stage), RP2 is abundantly secreted and easily detected in the peripheral blood circulation of the host. *P. falciparum* lacking *pfhrp2 = -ve result.*

Probability

- An understanding of probability is fundamental for quantifying the uncertainty that is inherent in the decision making process.
- Probability theory also allows us to draw conclusions about a population of patients based on known information about a sample of patients drawn from that population.
- only about 15% of lead compounds approaching preclinical candidate selection advance into clinical trials, …[] and only about 10% of compounds in clinical trials eventually become medicines….[]

Basic terms

- **A random experiment** is an experiment for which the ***outcome cannot be predicted*** with certainty, but all possible outcomes can be identified prior to its performance, and it may be repeated under the same conditions.
- A result of an experiment is called an **outcome**
- **Sample space -** set of **all possible outcomes** of a random experiment. It is denoted by **S**. **Example**, for the die it is the set {1, 2, 3, 4, 5, 6}
- **Equally likely:** A set of events is equally likely if one of them cannot be expected to happen in preference to another.
- **Mutually exclusive** events: if the occurrence of one of them preclude the occurrence of all others. **Example: tossed coin** outcome can be either head or tails. **Pr(A or B) = Pr (A) + Pr(B).**
- **Exhaustive events** if it includes all the possible events.
- **Conditional Probability**: The chance a patient with some disease survives the next year depends on his having survived to the present time.
- **Independent events**: Often there are two events such that the occurrence or non-occurrence of one does not in any way affect the occurrence or non-occurrence of the other.

Definition and Theoretical Basis of Decision Analysis in Health

What is Economic Evaluation?

Definition:

- **Economic Evaluation - systematic appraisal of costs and benefits of projects**, normally undertaken to determine the relative economic efficiency of programs.
- It's the identification, measurement, and evaluation and then comparison of the **costs** (inputs, resources consumed) and benefits/**outcomes.**
- In economic evaluations, the costs and consequences of alternative interventions or scenarios are compared to examine the best use of the scarce resources.

Why We study Economic Evaluation?

- The pressure of cost containment (control).
- The need for methods to evaluate interventions.
- Efficient resource allocation
- Help to illustrate tradeoffs between selecting one choice over another.
- one of the tools available to help choose wisely from a range of alternatives and implement efficient resources

Who uses Economic Evaluation?

Examples of users of EE in Pharmaceutical Care:

- **Hospital managers:** What drugs should be included on the hospital formulary?
- **Pharmaceutical companies:** What is the best drug for a pharmaceutical company to develop? Shall the company continue a clinical trial? What is the economic benefit of a new product?
- **Government:** Which drugs should be included in a medicine formulary?
- **Researchers**: How to improve the analytical credibility of economic evaluation?

Pharmacoeconomic Evaluation

- Makes use of the broad range of techniques used in health Economic Evaluation to the specific context of medicines management
- Common issues in PE evaluation
  - Perspectives
  - Costs
  - Outcomes (benefits)

PE Evaluation Importance

- **In Industry:** Deciding among specific research and development alternatives.
- **In Government:** Determining program benefits and prices paid
- **In Private Sector:** Designing insurance benefit coverage
- **In individual/patient level:** Selecting the optimal outcome through optimal cost

PE Evaluation Limitation

- The whole process may be open to bias
- Less well understood by doctors and others
- the existing cumbersome management structures

Decision Analysis

- Decision analysis is a quantitative method for evaluating decisions between multiple alternatives in situations of uncertainty
- Decision analysis is the application of an analytical method for systematically comparing different decision options.
- Decision analysis graphically displays choices and facilitates the calculation of values needed to compare these options.
- It assists in making decisions when the decision is complex and there is uncertainty about some of the information

Decision Analysis…

- "a systematic approach to decision making under conditions of uncertainty."
- It is an approach: ***Explicit, Quantitative, and Prescriptive***
- **Explicit -** It forces the decision maker to separate the logical structure into its component parts so that they can be analyzed individually, then recombined systematically to suggest a decision.
- **Quantitative** in that the decision maker is compelled to be precise about values placed on outcomes.
- **Prescriptive** in that it aids in deciding what a person should do under a given set of circumstances.

Decision analysis in Health

- Decision making in health care involves consideration of a complex set of diagnostic, therapeutic and prognostic uncertainties.
- Medical therapies have side effects, surgical interventions may lead to complications, and diagnostic tests can produce misleading results
- Furthermore, patient values and service costs must be considered.
- Decisions in clinical and health policy require careful weighing of risks and benefits and are commonly a trade-off of competing objectives: maximizing quality of life vs maximizing life expectancy vs minimizing the resources required.

When We Make A Decision?

- We make a **decision** when we irreversibly allocate resources.
- Goal of decision analysis is to clarify the dynamics and trade-offs involved in selecting one strategy from a set of alternatives
- Decision analysis used when:
  - There are real alternatives,
  - There is uncertainty,
  - There are serious of consequences.

Degree of Decisions

Decision varies in degree of:

- **Complexity**: large number of factors, multiple attributes, more than one decision-maker
- **Time factor**: static (no change over time) vs. dynamic (time-dependent)
- **Uncertainty**: deterministic vs. probabilistic.
  - **Deterministic** means there is no uncertainty and the problem can be solved with a set of precise equations. you have all of the data necessary to predict (determine) the outcome with 100% certainty.
  - **Probabilistic** subject to or involving chance variation. you are likely to get different results

Basic steps in decision analysis:

Step 1: Identify and structure the problem to be solved

Step 2: Gather relevant information, estimate probability.

Step 3: Identify the alternatives, assign value to alternatives.

Step 4: Weigh the evidence, calculate the best alternative

Step 6: Take action,

Step 7: Review your decision & its consequences

Decision Model

- **Model** is fundamental analytic tool used in decision analysis to display the temporal and logical sequence of decision problem
- Schematic representation of all the clinical important outcomes of a decision.
- Used to combine knowledge about decision problem from many sources
- Computes average outcomes (e.g, QALYs, costs, etc.) from decisions.

Decision Model..

- Decision model is chosen to represent the clinical problem
- Model needs to be simple enough to be understood, but complex enough to capture the essentials of the problem
- Fundamental purpose of a PE model is **to evaluate the expected costs and outcomes of a decision**
  - About the use of **a pharmacotherapy** compared with one or many alternatives
  - This **allows the investigator to test many alternative assumptions and scenarios**

Decision Model..

- The most important aspect of the decision modeling process is that **it must represent the choice that is being made.**
- When constructing a model of a clinical or pharmacological decision,
  - a **series of characteristics of the actual problem** must be represented in the model structure and method
- The model should **represent the set of reasonable choices** between which the decision maker must choose

Decision Model..

- Once the strategies are outlined, the modeler must enumerate the possible outcomes implied by each strategy.
- These outcomes are not always symmetric; a surgical therapy may have an ***operative mortality*** whereas a medical therapy may not
- However, **all potential outcomes** that can occur and are considered relevant to clinicians taking care of the problem should be included

Decision Model..

- To make an appropriate decision regarding **what consequences and outcomes** to include, the modeler must make decisions regarding **four characteristics**:
  - The **perspective** of the analysis,
  - The **setting** or context of the analysis,
  - The appropriate **level of detail or granularity**
  - The appropriate **time horizon**

Advantages of Decision Model

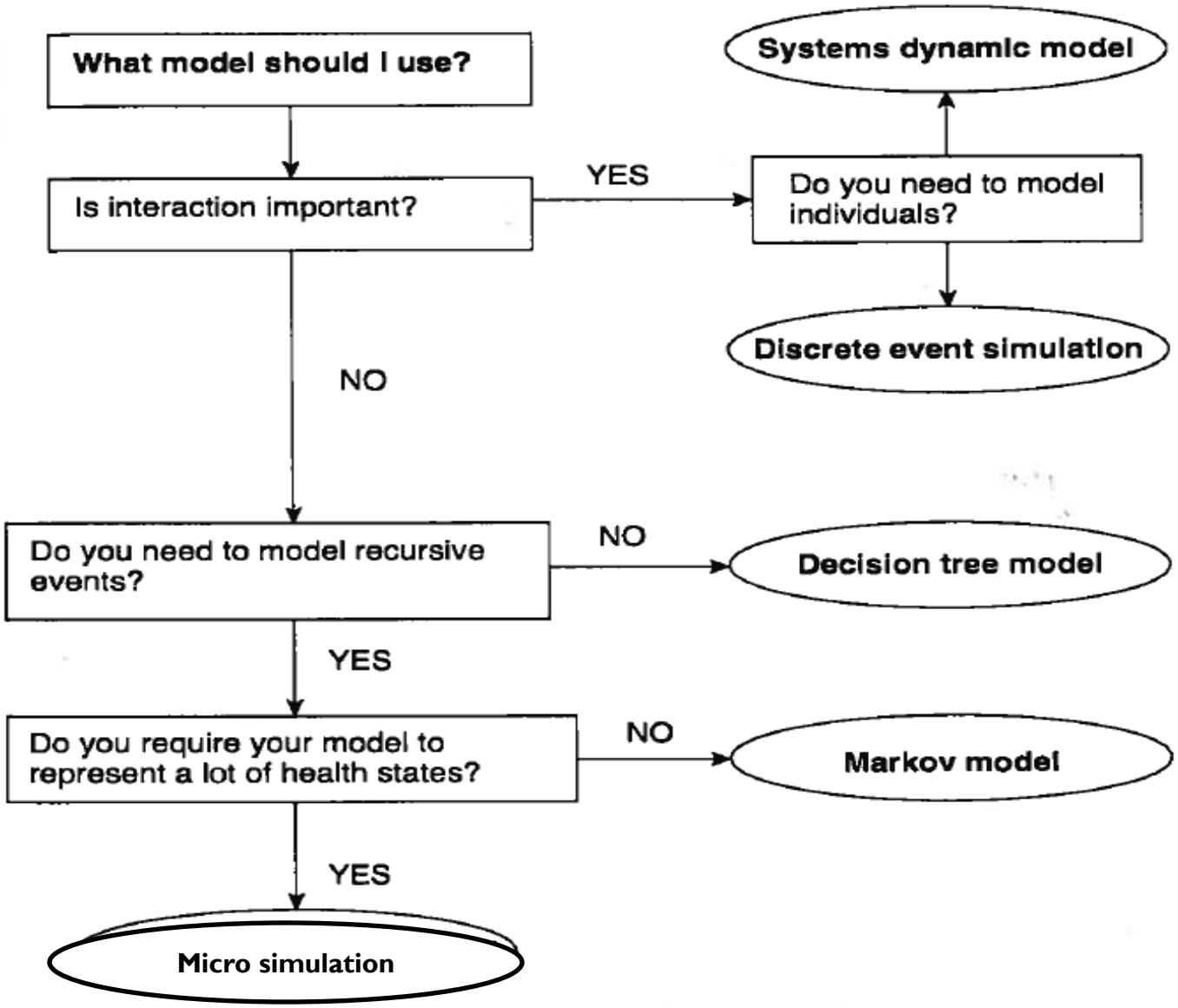
- **Comparison of all relevant options**
  - RCTs limited to a number of comparisons
  - Meta analysis for all options
- **Reflect all appropriate evidence**
  - Synthesize evidence from different sources (Obs. data RCT, meta analyses) on different outcomes (cost, clinical)
- **Link surrogate to hard endpoints**
  - e.g Blood pressure reduction to CVD,
- **Longer time horizons**
  - Follow up limited to duration of RCT. Effect maybe lifelong (QALY)
- **Adjust results to fit a specific decision-making context** (RCT not answering the decision problem, subgroup of interest)

Decision Models used for PE Evaluation

There are various types of models:

1. Decision tree model
2. State transition/Markov model
3. Simulation model
4. Deterministic (mechanistic) model
5. Agent based modeling

Selecting the type of model



1. Decision Tree Model

- This simple decision-analysis approach is well-suited for comparisons of t/t alternatives with relatively immediate consequences, i.e, curative t/ts
- A decision tree is **a tree-like** graph that consists of **branches** and **nodes**.
- Estimates the expected value of the outcome of interest (e.g. effectiveness, costs) associated with each of the studied strategies by weighting the outcome in every branch using conditional probabilities.

Steps in Decision Analysis Using Decision Tree Model

1. Framing the problem
2. Structuring the problem
3. Information gathering
4. Analyzing the decision tree
5. Interpret and implement findings

- Example 1: You have been asked to compare a new medication antibiotic A with the current standard antibiotic B to add the new antibiotic to a hospital formulary. The data needed for the decision analysis model are presented in the following table. Determine whether to add the new antibiotic A to a hospital formulary using decision tree model.

	Antibiotic A	**Antibiotic B**
Probability of t/t success	90%	70%
Cost of antibiotic per course of therapy ($)	600	500
Probability of adverse events	15%	20%
Cost of treating adverse events ($)	1,000	800

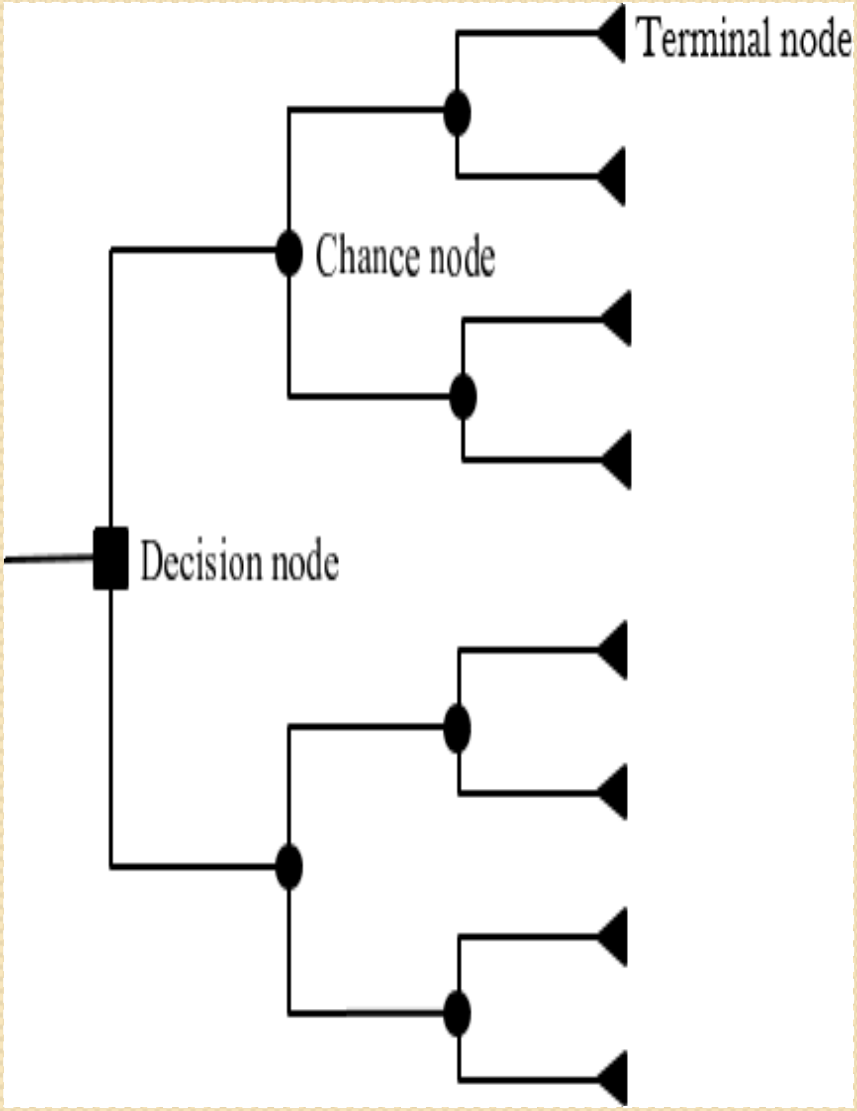
Step 1: Framing the problem

- The specific decision problem to be evaluated should be clearly framed by answering the questions:
  - what is the objective of the analysis?
  - what are the alternatives?

Step 2: Structuring the Problem

- Depict the components of the decision problem graphically using decision tree
- A decision tree provides a framework to display graphically different variables, including treatment options, outcomes associated with those treatment options, and probabilities of the outcomes
- We can then algebraically reduce all these factors into a single value, allowing for comparison

- Construction of decision tree is guided by a umber of conventions:
  - built from left to right
  - consists of: nodes, branches
- Nodes
  - are places in the decision tree where different options occur
  - branching becomes possible at this point
- There are three types of nodes:
  - decision node
  - chance
  - terminal node



Decision, Chance and Terminal Nodes

Decision Node

- Depicted as square
- Represents alternative actions are under the control of the decision maker
  - therefore, in a decision node, a choice is allowed

Terminal node

- Depicted as triangle
- Represents the final outcome of interest for each option
  - E.g. life or death, disability or health, positive or negative, QALYs, costs, …
- **Branches**
  - lines used to connect nodes with the nodes

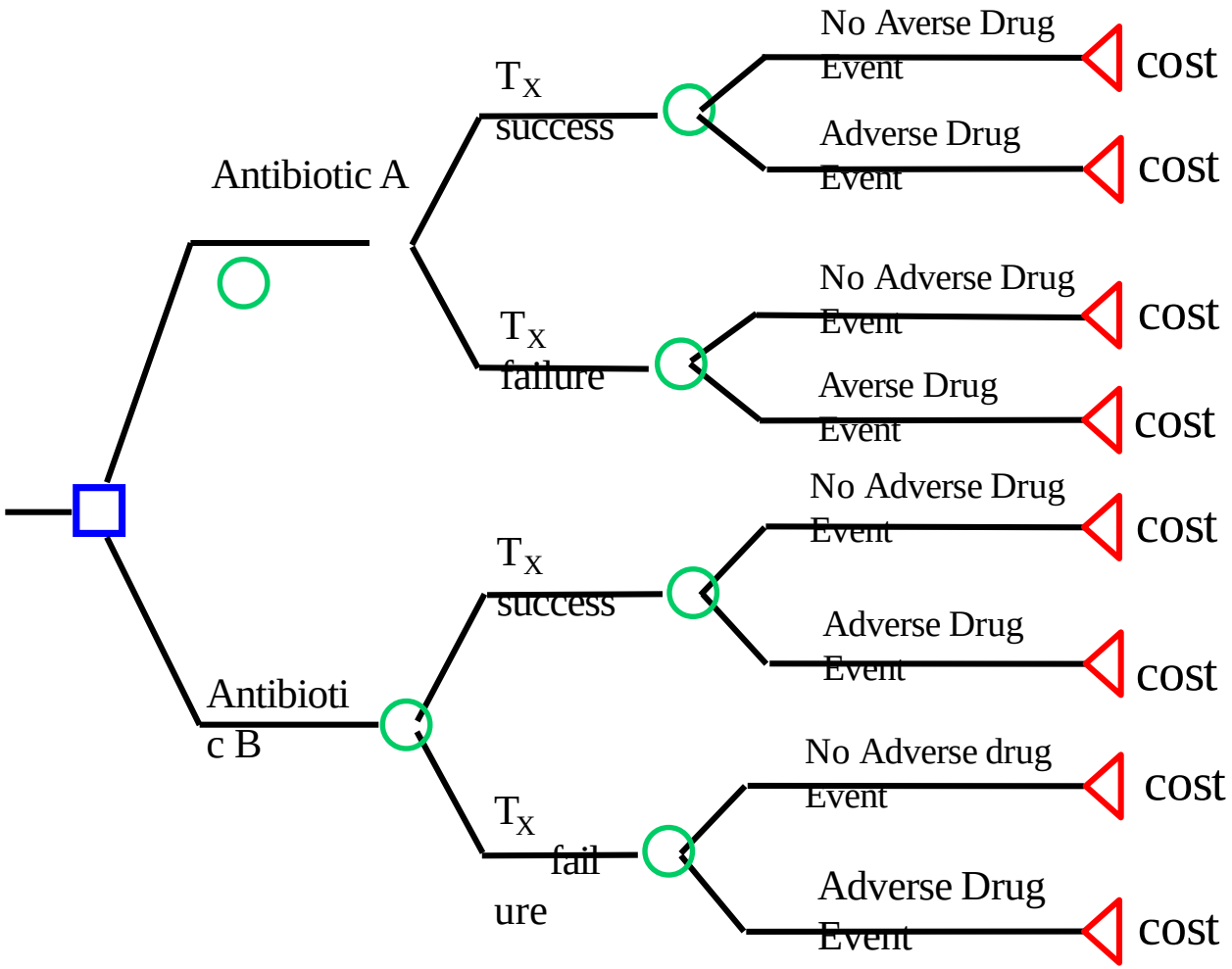
Chance Node

- Depicted as circle
- Represents events that are beyond the control of the decision maker
- Chances for the same events should line up horizontally
- Defines events that are mutually exclusive and jointly exhaustive. E.g. the chance or probability of cure. the chance or probability of adverse events
- At any given chance node the sum of the probabilities of the events must equal 1

What do mutually exclusive and jointly exhaustive mean?

- **Mutually exclusive**
  - only one alternative can be chosen
  - only one event can occur
- **Jointly exhaustive**
  - at least one event must occur
  - one of the possibilities must happen
  - taken together, the possibilities make up the entire range of outcomes

The complete decision tree for the antibiotic example problem

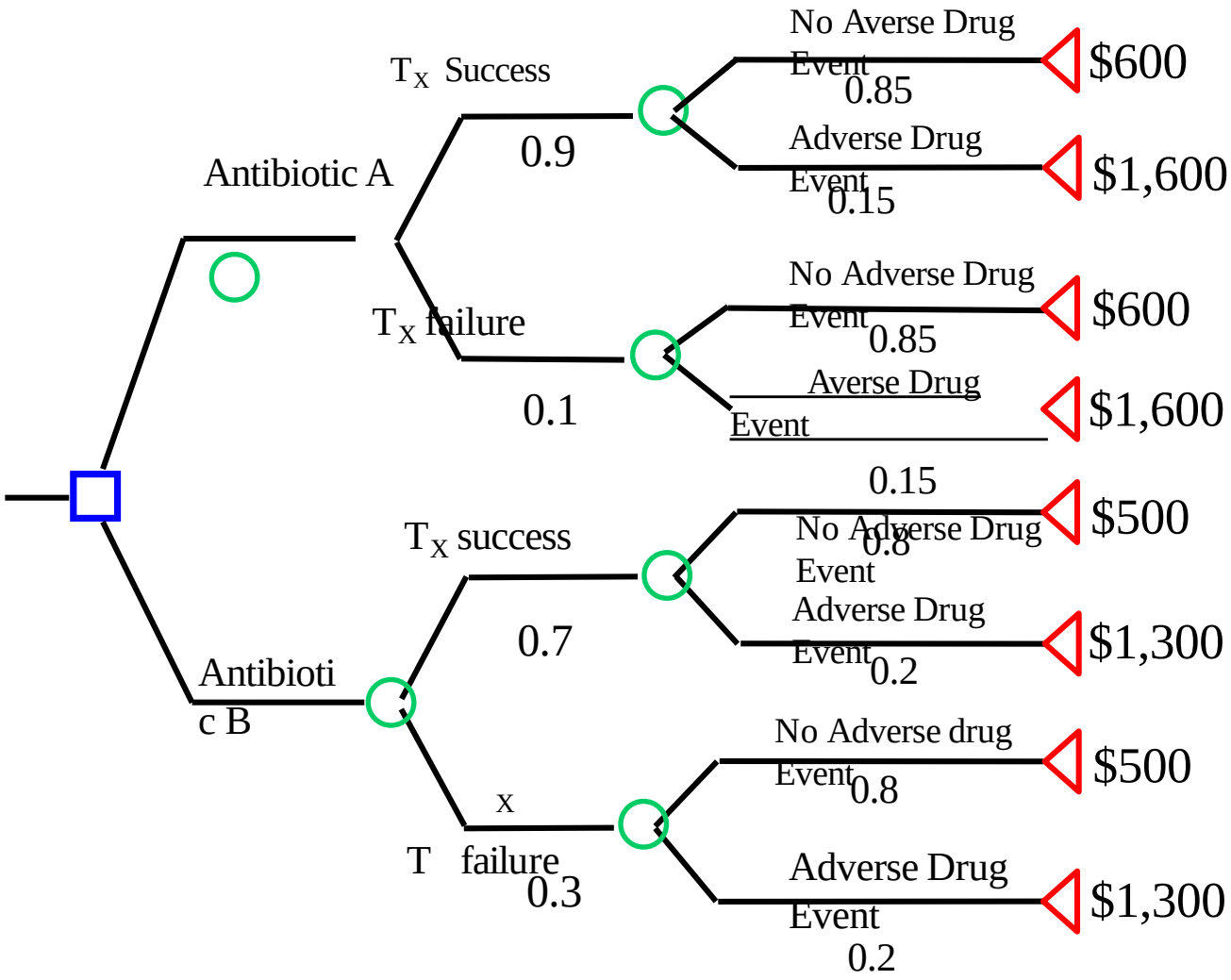


Step 3: Gathering Information

- the probabilities of outcomes can be manifested as efficacy rates and incidence of ADRs
- information on the probabilities of outcomes can be obtained from:
  - literature review, including meta analysis
  - primary data collection
  - consultation with experts
- then the information will be recorded on a decision tree
- information on the probabilities and outcomes/costs for the antibiotic example problem is presented in the next slide

	Antibiotic A	Antibiotic B
Probability of t/t success	90%	70%
Cost of antibiotic per course of therapy ($)	600	500
Probability of adverse events	15%	20%
Cost of treating adverse events ($)	1,000	800

Record the information on a decision tree



- For patients taking antibiotic A, the costs can range from $600 (for medication and no adverse events) to $1,600 (for medication and treatment of adverse events)
  - Total cost when there is no adverse event = $600
  - Total cost when there is adverse event = $600 + $1,000 = $1,600

- For patients taking antibiotic B, the costs can range from $500 (for medication and no adverse events) to $1,300 (for medication and treatment of adverse events)
  - Total cost when there is no adverse event = $500
  - Total cost when there is adverse event = $500 + $800 = $1,300

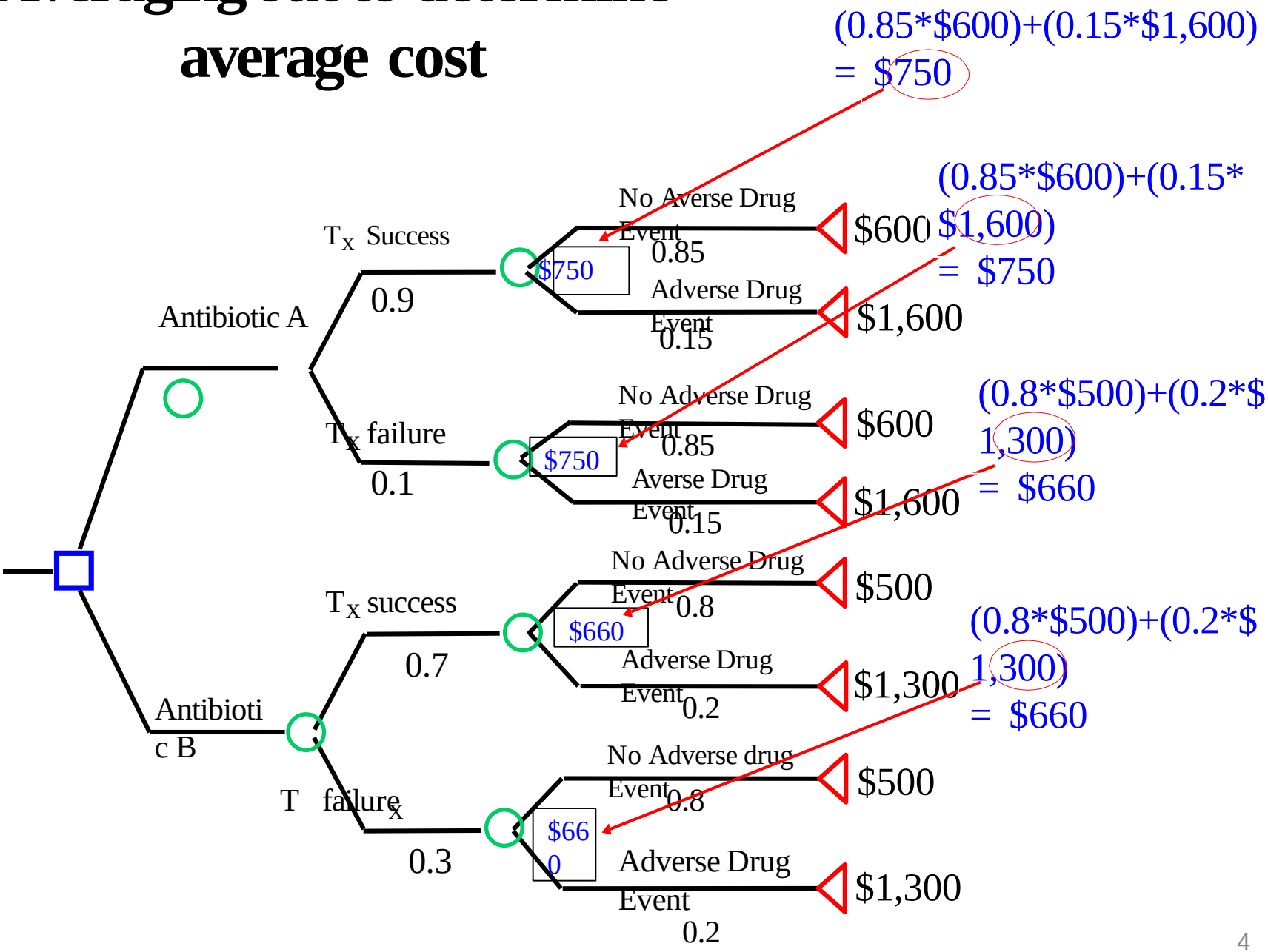
Step 4: Analyzing the decision tree

- the analysis is done by a process called averaging out and folding back to determine average outcome value
- the product of the probability of the event multiplied by the total outcome values (*p* of the event *outcome value of the event) is calculated for each node and then summed for each option

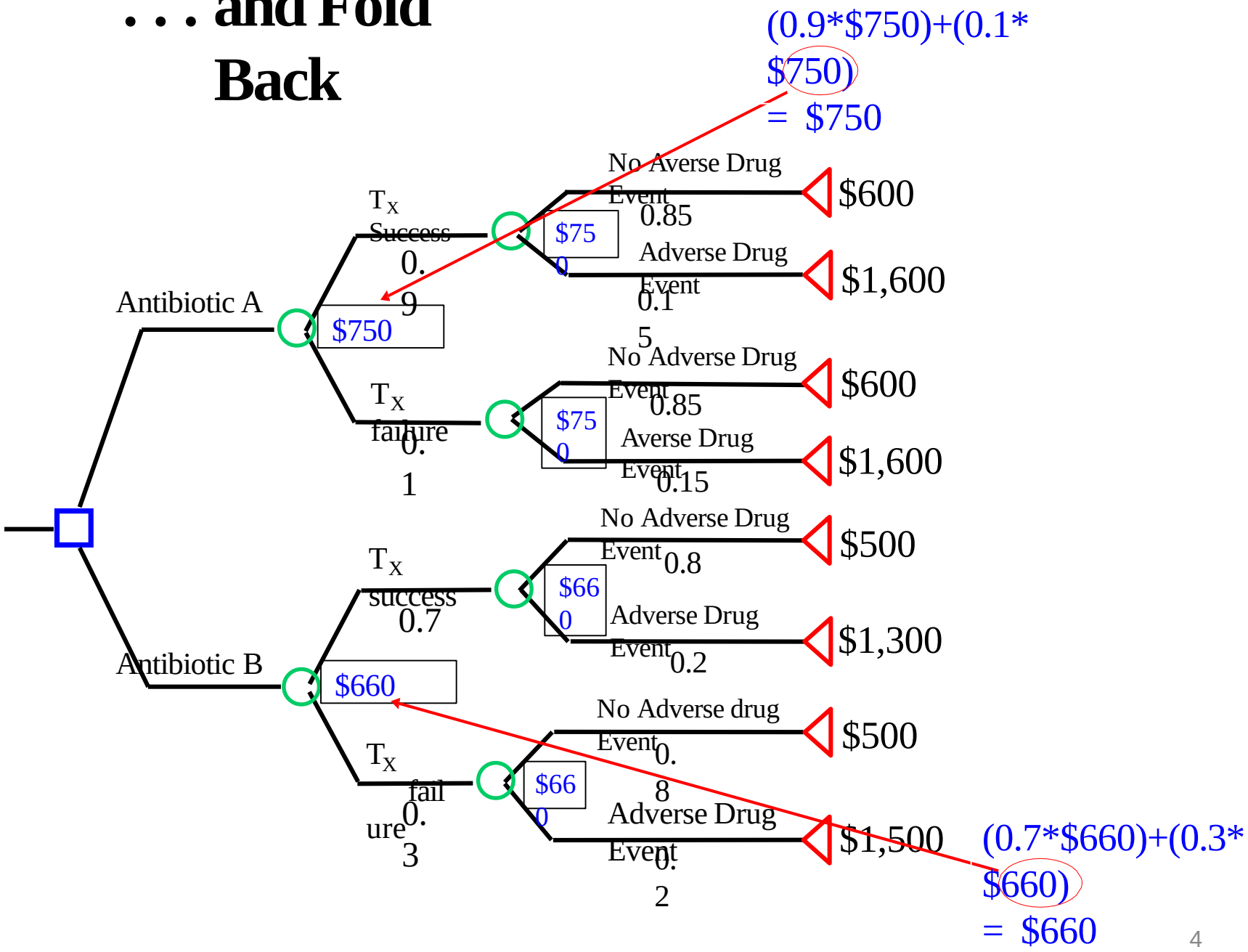
WA = [(*p* of event A) *(outcome value A)]+[(*p* of event B)*(outcome value B)]

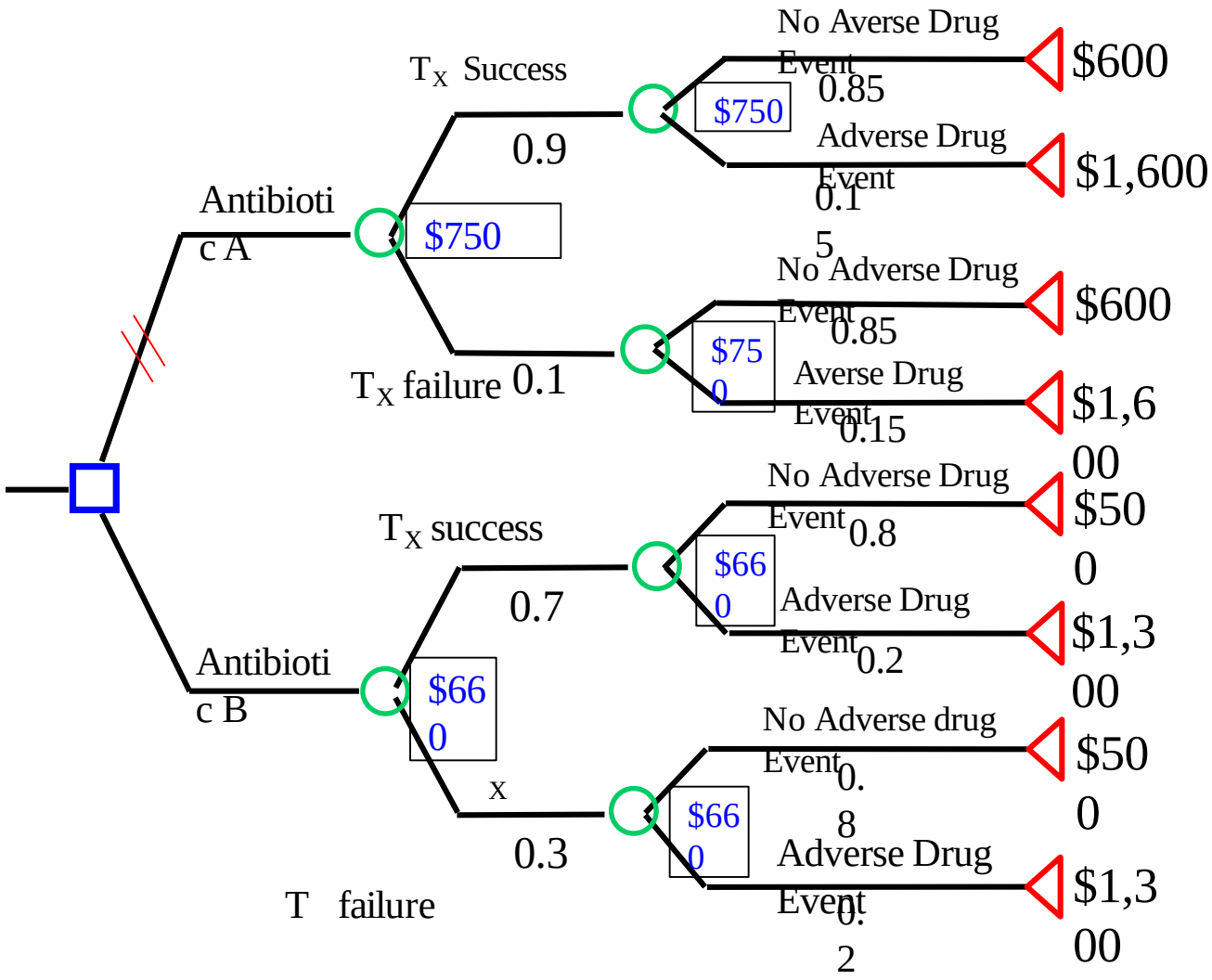
Where, WA = weighted average and *P*= probability

Averaging out to determine average cost



. . . and Fold Back




Antibioti
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Step 5: Interpret and Implement Findings

- For antibiotic A, the average cost is $750 per patient
- For antibiotic B, the average cost is $660 per patient
- Antibiotic B is less expensive even when including the costs of treating adverse events ($660 Vs $750)
- Since antibiotic A is a better clinical option (higher probability of success and lower probability of adverse events), We have to determine ICER for decision making…ICER: Incremental Cost Effective Ratio

$$ICER = \frac{\Delta Cost}{\Delta Effectiveness} = \frac{\$750 - \$660}{0.9 - 0.7} = \mathbf{\$450 \text{ per additional t/t success}}$$

- If We choose antibiotic A, each extra successful outcome costs $450. This is lower than costs of treatment failure with antibiotic B which range from $500 to $1,300
- For extra successful outcome We achieve with an expense of $450, there will be faster patient discharged from the hospital, We can avoid second round treatment costs with another antibiotic, and so on
- Antibiotic A is more cost effective
- therefore, antibiotic A will be added to the formulary and antibiotic B will be deleted from the formulary

Limitation of Decision tree

There are two common types of limitation in using decision tree model

1. It does not show the time horizon explicitly i.e. the discounting issue also in problem as time is implicit and analyst can't show it easy from figure.
2. Decision model can be very complex for complicated pathways and the chance is increasing to be very complicated and if so it is very difficult for analyst and analysis

2. State transition (Markov) models

- Markov models were first developed by the Russian scientist Andrei Markov (1856–1922)
- For many diseases and conditions, more complex outcomes and longer follow-up periods need to be modeled.
- For these analyses, **patients may move back and forth**, or transition, between **health states over periods of time.**
- Example, a patient who has a blood clot (embolism) may be given a *blood thinner (anticoagulant*) to reduce the risk of further embolisms.
- Three possible health states are
  - Patient dies from the embolism,
  - Patient has blood-related problems from the medications (e.g., internal bleeding), or
  - the patient lives with no complications or side effects.

State transition (Markov) model

- Outcomes past this initial health state can be followed further to see whether patients develop future embolisms or future internal bleeding.
- Each follow-up interval is called a cycle, the time period that is determined to be clinically relevant to the specific disease or condition.
- Cohort: Best for models with manageable number of states.
- Based on states an individual can occupy over lifetime (e.g. healthy, sick, stable, progressed, dead)
- In a Markov model the probability of a trial outcome varies depending on the current result not the prior natural history (generally known as a "state"). Markov assumption: no "memory" within states (the duration of stay in state) before.
- *Each state associated with a cost and a health outcome ($'s, LYs or QALYs)*
- *Transition between states with some probability*
- *Transitions occur in cycles (months, years etc)*

Markov model Cont…

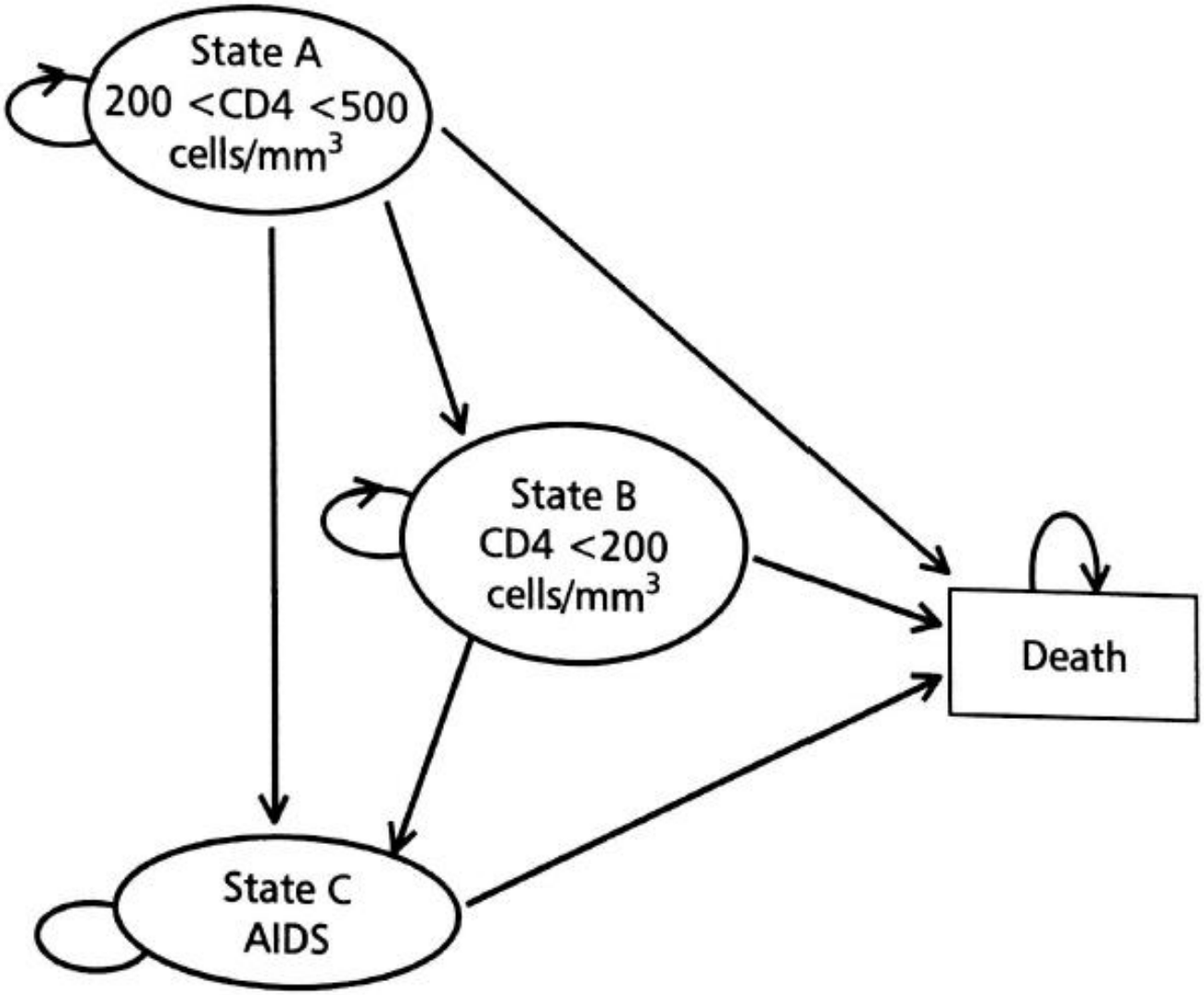
- The other principal category of Markov models is absorbing.
- In these systems the process has a state that it is possible to enter, in a finite set of moves, from any other state, but from which no movement is possible.
- Once the process enters the absorbing state, it terminates (i.e., stays in that state forever) like death.

Steps in Markov Modeling

There are five steps for Markov modeling:

1. Choose the health states that represent the possible outcomes from each intervention;
2. Determine possible transitions between health states,
3. Choose how long each cycle should be and how many cycles will be analyzed,
4. Estimate the probabilities associated with moving (i.e., transitioning) in and out of health states;
5. Estimate the costs and outcomes associated with each option

Markov Model



Transition probabilities—monotherapy

	Transition to			
Transition from	State A	State B	State C	State D
State A	0.721	0.202	0.067	0.01
State B	0	0.581	0.407	0.012
State C	0	0	0.75	0.25
State D	0	0	0	1

Transition probabilities—combination therapy

	Transition to			
Transition from	State A	State B	State C	State D
State A	0.858 (1−sum)	0.103 (0.202×RR)	0.034 (0.067×RR)	0.005 (0.01×RR)
State B	0	0.787 (1−sum)	0.207 (0.407×RR)	0.006 (0.012×RR)
State C	0	0	0.873 (1−sum)	0.127 (0.25×RR)
State D	0	0	0	1

- Expected costs and outcomes:
  - The summed costs/outcomes from every state over time averaged over the patients
- How to do it:
  - First estimate the probability of an individual in every state each cycle
  - Assign costs and outcomes on every state for every cycle
  - Sum and average (discount if needed)

- Markov models for chronic conditions with multiple events easier modelled through individual state transition models than cohort models
- Decision trees with attached Markov models commonly used.
- Time dependency added through time dependent probabilities.
- Relaxing the markov assumption (adding memory) possible with added complexity
- More complex decision problems (e.g. infectious diseases) may require stochastic modelling, DES

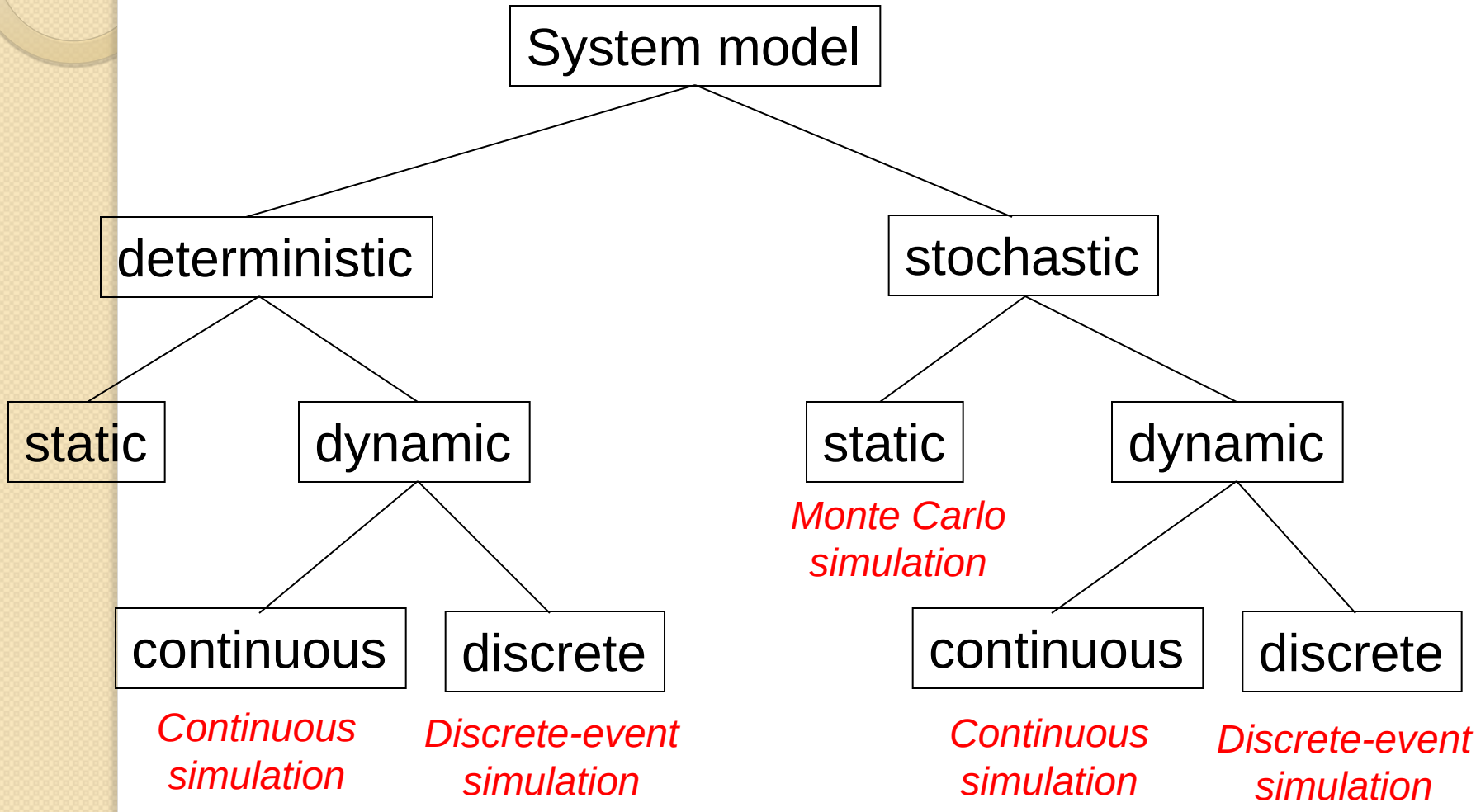
Disadvantages of Markov Modeling

- Markov models can be more complex than simple decision trees: less transparent to decision makers.
- Researchers strive to strike a balance between developing models that are more complex but better able to capture the true nature of the disease state and developing simpler models that are easier to interpret but may not include important clinical factors.
- A commonly cited disadvantage of Markov modeling is that it is "memoryless" because the Markovian assumptions that the probability of moving from state to state is not based on the previous experiences from former cycles.
- In practice, a patient's medical history is an important determinant in the probability of his or her future health. More advanced and complex computations, such as using tunnel states, allow for integration of health experiences from previous cycles.
- Another disadvantage is that the data needed to estimate probabilities and costs, especially in the long term, are often unavailable. Most clinical studies measure outcomes for a short time, and extrapolation into the future may compound errors in estimations

3. Micro simulation

- The term micro simulation has come to represent those models in which **individual patients are modeled, one at a time**, as they proceed through the model.
- The advantage of micro simulation is that it eliminates a problem with standard
- Markov process models in that it releases the assumption of path-independent transition probabilities.

Types of Simulation Models



Stochastic vs. Deterministic

- Stochastic simulation: a simulation that contains random (probabilistic) elements, e.g.,
  - Examples
    - Inter-arrival time or service time of customers at a store
    - Amount of time required to service a customer
  - Output is a random quantity (multiple runs required analyze output)
- Deterministic simulation: a simulation containing non random elements
  - Examples
    - Simulation of a chemical reaction based on differential equations
  - Output is deterministic for a given set of inputs

4. Discrete event simulation

- One of the problems with many of the modeling systems previously discussed is that they cannot easily model the ***competition for resources***.
- Therefore, although a decision analysis or a cost-effectiveness analysis might be able to determine that a particular diagnostic or therapeutic strategy should be adopted, these analyses cannot tell whether the resources, delivery systems, geographic constraints, or other problems allow for the **optimal strategy to actually be implemented**.
- Discrete event simulation, which was originally developed over many years ago by industrial engineering to model production processes in factories, provides the modeler with a set of tools that can represent queues, resource limitations, geographic distribution, and many other physical structures or limitations that constrain the implementation of a particular strategy or therapy.

DEM

- *Discrete-Event*: significant changes occur at discrete time instances
- Changes occur at a separate points of time
  - i.e., The system can change only at a countable number of points in time.
- What does it change the system state? Events
- **Event:** is an instantaneous occurrence that changes the state of the system Examples: Arrival of a new customer, a departure of a customer from a queuing model
- FIFO or FILO

5. Agent-based models

- Agent-based models, in which each "agent" or component of the model *independently contains all of the information it needs to interact with and respond to the actions of the other agents in the model*, have been increasingly used to understand and model complex biological systems, from individual cells and organs to populations.
- One fundamental concept of agent-based models is that the aggregated behavior of multiple individual autonomous agents can replicate and predict very complex social and group behaviors

Agent Based Modeling…

- Simulation modeling technique where a system is modeled as a collection of agents and the relationships between them.
- Agents individually asses its situation in the environment and make decisions on the basis of a set of rules.

Software for decision modeling

1. TreeAge

- **Advantages of TreeAge:**
  - User friendly
  - Commercially available = liability
  - Flexible
  - Beginners can build a much better model, fast!
- **Disadvantages of TreeAge**
  - Slow
  - Limiting when it comes to complex DAMs
  - Less flexible than Regression ® for building complex policy models

Software for decision modeling

2. Excel

- Advantages of Excel:
  - Available to almost everyone
  - Familiar interface
  - Widely used , lots of examples on line
  - Transparency
- Disadvantages of Excel
  - Macros require knowledge of VBA programming
  - Slow
  - Limited complexity, hard to do micro simulation
  - Relies on other software for the statistical components of the model

Software for decision modeling

3. R Software

- Advantages of R:
  - Available to everyone (open source)
  - No restrictions on the amount of complexity
  - Can embed statistical models in DAMs
  - Provides a platform to embed all components of the model in one framework
  - Fast
- Disadvantages of R
  - Steep learning curve
  - more room for error
  - Open source= no liability

Uncertainty in Decision Analysis Model: 1. Variability

- When the characteristics of the individuals in the model differ between each other

  e.g. large variability on the starting age of the model population.

- Solution: Subgroups/sensitivity analysis with different population characteristics
- Incorporate variability in micro simulations
  - Distribution on patient input

2. Parameter uncertainty

- Uncertainty associated with sampling of input parameters.
  - e.g. mean SBP reduction from RCT comes with estimate of uncertainty (variance)
- Solution: probabilistic sensitivity analysis (PSA)
  - Sample from distribution of input parameters and estimate distribution of output.

Probabilistic Sensitivity Analysis

- Characterize uncertainty of input parameters
  - Assume a distribution around each input based on the parameter uncertainty e.g. from the RCT
  - Type of distribution dependent on type of data
- Propagate the model with uncertainty
  - Monte Carlo simulation (random draws from all assumed distributions)
- Present the implications of uncertainty.
  - Confidence intervals,

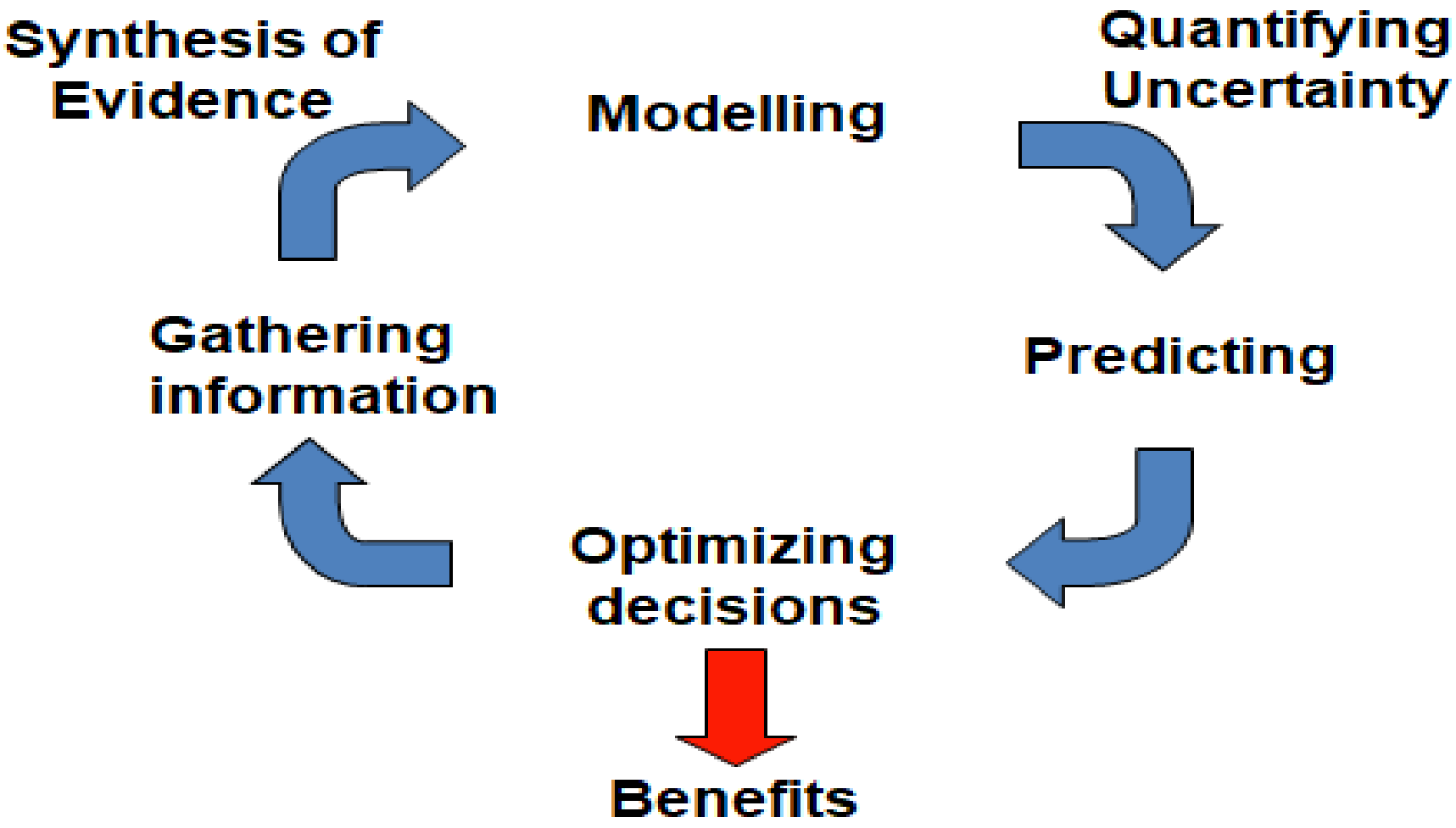
3. Structural uncertainty

- Uncertainty associated with modeling decisions.
  - Example 1: assumption on the type of survival model used in an RCT
  - Example 2: conduct a micro simulation rather than Markov model
- Possible solution: model averaging

Steps in Decision Analytic Modelling

1. Conceptualizing the problem
2. Conceptualizing the model
3. Finding the right input data
4. Running the model
5. Validating the results using the following general approach

General approach of Decision Analysis



- Consulting with experts and stakeholders
- Clear presentation of the decision problem the objectives, scope and assumptions
  - Scope should be inline with decision problem
  - Perspective
  - Target population relevant to the decision(subgroup analyses, incident vs prevalent)
  - Outcomes relevant to the decision maker
  - Appropriate selection of interventions

1. Conceptualizing the problem

- The decision problem structures the model and not the availability of data
- The model horizon long enough to capture effects of all interventions
- Model uncertainty taken into account
- Policy model clearly stated

2. Conceptualizing the model

- Choosing the right model for the right question
  - Unit of representation: individuals vs cohort
  - Interactions between units in the model
  - Time horizon and time measurement
- Simplicity in modelling is good – transparent models. however models as complex as needed and no less.

3. Finding the right input data

- The appropriate input data about the health outcome and the cost of the intervention for the problem we want to solve.
- Basically the
  - Direct and indirect cost
  - Perspective of the study
  - Outcome of the study
  - And the major assumption used for the analysis

4. Running the model

- Running the model of the analysis to make the study figurative
- Make the model as supporter of the analysis rather than making ultimate indicator.
- Make the model compatible with assumptions

5. Validating the results

- Check the result is representative with data sources(perspectives)
- Be sure that you are excluding or including the states changed after data were collected
- Organize the result based on the requirement of audiences.
- Compare with the previous works to make valuable for next decision.

6. Reporting the evaluation

- Report the evaluation in a transparent and detailed manner.
- Provide enough information to enable the audience to critically evaluate the validity of the analysis.
- Include a **summary and a conclusion** of the evaluation that are written in **nontechnical language** and that are accessible to the target audience.

- Present the analysis in disaggregated detail first, showing total, undiscounted costs and outcomes separately for the intervention and each comparator.
- Introduce aggregations, incremental results, and value judgments as late as possible.
- Report final results as incremental cost effectiveness ratios (ICERs), based on incremental differences of expected costs and expected outcomes of the alternatives.
- Follow standard decision rules for estimating ICERs, including the exclusion of dominated alternatives.
- Analysts are encouraged to present the results of the analysis in graphical or visual form, in addition to tabular presentation.

- Describe funding and reporting relationships of the evaluation, and disclose any conflicts of interest.
- Make documents demonstrating quality assurance in the conduct of the evaluation available to decision makers.
- If requested, make a copy of the model available to decision makers for review.

Possible Benefits of Decision Analysis in Health

- Evidence based treatment decision
- Reduces cost of unwanted drug therapy
- Development of formulary system
- Drug cost and patient income can be balanced
- Policy makers can use for policy development
- Drug manufacturing can use as input
- Reduces the cost of the society and increases positive consequences.

Common Criticisms of Decision Analysis in Health

- Often economic evaluations are not transparent (users do not know what data, including estimates and assumptions, went into the analyses).
- Do not include information on budget impact (the estimated effect on the overall cost of adding a product to the formulary).
- Other reasons given for the slow acceptance of economic evaluations include the lack of expertise and the lack of national resources devoted to research
- Decision makers may mistrust the results of these studies.

End of
Chapter Three
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THANK YOU!